Research Paper | Engineering | E-ISSN No : 2454-9916 | Volume : 7 | Issue : 10 | Oct 2021

INTEGRATED CREW AND RESERVE CREW SCHEDULING UNDER UNCERTAINTY CONDITION

*Zahra Armand, M.Sc.[1] | Saba Karimi Azam, M.Sc.[1] | Milad Soraghi, M.Sc.[1]

[1]Department of Industrial Engineering, Faculty of Engineering, Alzahra University, Tehran, Iran. (*Corresponding Author)

ABSTRACT

Scheduling algorithms in Airline crew seemingly has some points of disruptions, which causes great expenditure. We, therefore, have designed algorithms for solving this issue. The suggested model is an approximation of crew under uncertainty condition. We have considered that all pairings would operate as pre-scheduled. Our findings revealed that the crew schedule operate better in disruption operation. The crew schedules found using our method perform better relative to lower bound.

KEYWORDS: airline, planning, crew, schedule.

INTRODUCTION:

Crew scheduling is defined as the problem of assigning a group of workers (a crew) to tasks. The crews are typically interchangeable, although in some cases different crews possess different characteristics that affect which subsets of tasks they can complete. For major carriers, crew costs are second and they come after the fuel costs. In other words, they may surpass $1 billion annually. Hoffman and Padberg1 reported the exceed of $1.4 billion at the airlines during1990s while a senior pilot earned up to $250,000 annually. Therefore, airlines decided to devote time and specialty for planning good crew schedules. Although the planning has many conditions since there are contractual regulations concerning the staff presence, there are billions of possible solutions.

The current concern nowadays is about air traffic congestion. Previously, flight delays were up to 24%. Moreover, air traffic in the United States and Europe is expected to double in the next 10–15 years. If airport capacity remains constant, it is estimated that increase in airport traffic will bring about a great deal of increase in crew delays[2].

Recovery is the defined as reacting to a disruption although optimal recovery decisions are seemingly difficult to determine.in the uncertain condition of future, cancelling a leg or rerouting a crew might be of costly consequences for the system. However; it was the theory while in practice, airlines bring to practice the manual recovery decisions[3]. This process makes airline recovery difficult since the decision makers use subjective judgment. Most optimization factor is on crew population, but we are still unaware of any dynamic and stochastic airline recovery designs.

Airline operations are affected by Crew planning greatly. Airlines vividly delay flights if the crew is unavailable is a case of example. Another example goes back to when pilots refused to work overtime in order to show their anger and unhappiness with the new contract, the result of which caused the airline millions of financial loss.

Although working in a highly uncertain condition in reality, too few design models consider Airline uncertainty in operation. The reason lying behind this is the management, which does not measure the quality of a plan by its performance. In this regard, a plan is evaluated by the quality of the plan, not by operational performance. The length of the disruption is the leading factor for defining airline disruptions which is based on the length of the disruption. The first subcategory is a frictional disruption. Examples include delays due to connecting passengers, airport congestion, brief and unscheduled maintenance incidents, and localized, short, weather disruptions. Lengthy, unscheduled, maintenance disruptions and large-scale, severe, weather disruptions are the other end of this condition. Disruptions may have aspects of both frictional and severe. However, this study has been limited to frictional disruptions in order to demonstrate the progression of deterministic crew scheduling models.

Scheduling the crew:

Typically, pilots could only fly one type of aircraft the majority of times. Consequently, the crew scheduling is separated by fleet type. When a crew member is set on duty, it flies a set of consecutive flight legs that follow certain regulations. Set of legs is called a duty. The sit time is the time between two consecutive legs within a duty. The elapsed time is the number of minutes that elapse between the beginning of a duty and its end, which includes a briefing period before the first leg and a debriefing period after the last leg. Since a crew member could fly only one fleet type, problematic issues with the fleet and the aircraft rotation are usually solved before the crew scheduling problem. If a crew flies two consecutive legs on different planes, the scheduled connection time between these legs must exceed a minimum connection time. A schedule is a combination of pairings that partitions the legs to be flown by a single fleet. Generating pairings and integer program could possibly solve the crew scheduling issues, the assumption of which is that each leg is flown every day. The crew scheduling problem is usually modeled as a set partitioning problem where aij , the ij th entry of the matrix A, is 1 if pairing j flies leg i, and 0 otherwise, therefore we have: min cx: _ Ax=1, x binary.

Crew Schedule evaluation:

There is an ongoing demand in finding good crew schedules for airlines, although we cannot yet define the meaning of good for a crew schedule. Airlines have traditionally evaluated a crew schedule by its planned cost. The notion here is that every leg will be operated as pre-programed, but evidence reveals different scenario in reality. In this paper the evaluation of a crew schedule was described by its performance in operations with disruptions. In order for the crew schedule's performance to be operated in practice, mechanisms and probabilities of disruptions should first be specified, and then a recovery policy should be set.

The main model of this research is multi-objective planning, which in this research has two objective functions and the first objective function (optimal allocation of crew and reservation service to the aircraft) has the first priority and the second objective function (maximizing profit per flight) has In this model, ideal planning is assigned to each of the objective functions, specific ideals in accordance with the goals and strategies of the airline, and each of these objective functions with the corresponding ideal in the first and second constraints of the model. Then, ideal planning is specified.

The objective function of the ideal planning model is designed and inserted with the aim of minimizing the number of deviations of each of the objective functions of the primary problem of ideals in order to minimize the number of deviations from the ideals specified by the airline organization in addition to achieving an efficient answer. This ideal planning model will ultimately provide the optimal answer to the amount of crew and reserve crew allocation to different flights so that the cost of each flight is minimized. The main proposed model of the ultimate multi-objective function has been designed.

RESULTS:

The goal or the first priority regarding the optimal allocation of crew and reservation crew is for different flights. Therefore, in the goal function of the multi-objective model, the amount of deviations related to it is considered positive. The goal with the second priority is to maximize the profit of different flights. Therefore, in the goal function of the multi-objective model, the amount of deviations related to it is considered negative. Also, for each of the objective functions, ideals 1 and 2 have been assigned and then an attempt has been made to minimize the number of deviations from the ideals, which is included in the limitations of the final objective function. Also, since an objective function cannot have more or fewer values than the ideal at the same time, we have used two final constraints in this regard.

$$Min\ P_1 d_1^+ \text{ و } P_2 d_2^-$$

s.t :

$$\sum_{ijk}\left(\left(\sum_{m} CF_m * NF_m\right) + \left(\sum_{n} CP_n * NP_n\right) + \left(\sum_{ijk} CS_{ijk} * NS_{ijk}\right) \right) A_{ijk} - d_1^+ + d_1^- = Z_1$$

; i=1 to 6 , j=1 to 27, k=1 to 27, m=1 to 4, n=1 to 4

$\sum_{ijk}\left(\sum_{ijk}(N_{ijk} * B_{ijk}) - CF_{ijk}\right) A_{ijk} - d_2^+ + d_2^- = Z_2$; i=1 to 6 , j=1 to 27, k=1 to 27

$NF_m \leq NF_{max}$;m=1 to 4

$NP_n \leq NP_{max}$; $n = 1\ to\ 4$

$NS_{ijk} \leq NS_{max}$; i=1 to 6 , j=1 to 27, k=1 to 27

$NF_m \geq NF_{min}$;m=1 to 4

$NP_n \geq NP_{min}$;n=1 to 4

$NS_{ijk} \geq NS_{min}$; i=1 to 6 , j=1 to 27, k=1 to 27

$N_{ijk} \leq n_{max}$; i = 1 to 6 , j = 1 to 27, k = 1 to 27

$B_{ijk} \leq b_{max}$; i = 1 to 6 , j = 1 to 27, k = 1 to 27,

$N_{ijk} \geq n_{min}$; i = 1 to 6 , j = 1 to 27, k = 1 to 27

$B_{ijk} \geq b_{min}$; i = 1 to 6 , j = 1 to 27, k = 1 to 27

$d_1^+ . d_1^- = 0$

$d_2^+ . d_2^- = 0$

$NF_m\ and\ NP_n$ and $NS_{ijk} \geq 0$, Integer ; i=1 to 6 , j=1 to 27, k=1 to 27, m=1 to 4, n=1 to 4

$A_{ijk} \geq 0$ or 1 ; i=1 to 6 , j=1 to 27, k=1 to 27

$d_p^+ \text{ و } d_p^- \geq 0$; $p = 1 - 2$

Considering that we have a reserved device, to determine the minimum amount of flight crew that we have and to reach the damaged point, we chose the coefficient value equal to 0.25 because we considered the reservation period to be 4 hours, 0.25 multiplied by the total four-hour demand. This means that we deliver the flight crew to the devices for at least one hour of the reserved device. According to the description and considering the membership rates of 0.3 with coding in Lingo 10 software and solving model 1, the following answer can be seen:

Objective value: 0.9666540E+08

Variable	**Value**
F(1)	1
F(2)	1
F(3)	1
X(1, 1, 2, 1)	3337800
X(1, 1, 6, 1)	45400
X(1, 1, 7, 1)	2499
X(2, 1, 6, 1)	26400
X(2, 1, 7, 1)	4827
X(3, 1, 6, 1)	26400
X(3, 1, 7, 1)	4827
VN(1, 1, 1)	1
VN(2, 1, 1)	1
VN(3, 1, 1)	1
Y(1, 1, 2, 1)	612421
Y(1, 1, 3, 1)	976
Y(1, 1, 6, 1)	183200
Y(1, 1, 7, 1)	267153
Y(2, 1, 6, 1)	34607
Y(2, 1, 7, 1)	328462
Y(3, 1, 1, 1)	319807
Y(3, 1, 2, 1)	347000
Y(3, 1, 3, 1)	158927
Y(3, 1, 4, 1)	80264
Y(3, 1, 5, 1)	159903
Y(3, 1, 6, 1)	102000
Y(3, 1, 7, 1)	44000
VP(1, 1, 1)	46
VP(2, 1, 1)	55
VP(3, 1, 1)	352

In production engineering and in various companies such as airlines, the profit control department and profit engineering department is the department that is engaged in creating methods so that the crew, booking, and sales can use those methods to ensure the appropriate cost of their company[4]. These methods and systems are usually designed in collaboration with other engineering and business disciplines. Flight profit is one of the topics of industrial and systems engineering. In addition to profitability, profit control also increases the productivity of the organization. In this regard, depending on the type of effective factors in profit and the scope of the study, statistical profit control, profit guarantee, and comprehensive profit control have been proposed5. From the mentioned controls, they need the basics and tools that their design and implementation are studied in industrial and systems engineering. Consumption and production are responsible and booking is an important part of this process[6].

The challenge for most airlines, when faced with declining profits and services of those institutions, is to find the reasons for the decline in profits and services of these organizations. Experts attribute the reasons for the low profitability of goods and services usually to mismanagement, lack of proper planning, and underestimation of the profit control task. The first person responsible for maintaining the profit of a product or service is the director of the production or Service Company. Because managers must control the stages of work progress in all job categories in their system[7]. Profit control monitors the amount of profit earned, so management can determine if the steps were appropriate for the project. When the rate of the deficit is higher than expected, profit control can help clarify the reasons and take action to address the problem8. Crew reservations are affected by profit control and inspection reports, and various flight and crew reservations and sales always occur, inflicting great economic losses on industry owners and governments. In this paper, the different concepts such as profit, profit control, booking and classification, booking management system, supply chain, booking and sales and comparing it with business supply chain, multi-objective optimization problem and its solutions, fuzzy logic, basic concepts were all negotiated. a few models were suggested for improving the reserve management chain based on earnings control and previous research in this area. A multi-objective phase model for planning booking operations and booked flights, were proposed and the practical performance of the model was assessed.

CONCLUSION:

The first goal was to minimize the cost of booking operations and the second goal was to maximize the demand-to-demand ratio. These two goals are opposed to each other, because the goal of cost minimization is to minimize costs and thus reduce traffic and reduce the transfer of different flights, and Airbus in some cases selects the optimal item to activate the flights according to Passes control to the lowest cost profits, while the goal is to maximize the demand-to-demand ratio, delivering the maximum number of possible crew flights to meet the reserved device demand. A multi-objective model was presented with the phase demand parameter, and we considered reservation reports and profit control through the supply of crew flights as phase parameters in the model. We considered limitations such as capacity, crew capacity for Airbus, receiving capacity for the booked crew, and minimum receipt of all types of flights per booked crew. One of the most important issues in project management is choosing the best possible option to perform each of the activities that make up the project so that the cost and final time of the project have the least possible amount. Therefore, this includes the two goals of minimizing operating time and minimizing the cost of all projects that must be optimized simultaneously. On the other hand, in real construction projects, the estimated costs for carrying out activities are usually accompanied by uncertainties that lead to a large change in the cost of the project. Therefore, an ideal planning model for solving this problem has been presented in this paper. The goal function is to maximize the membership amount of the two goals that make up the phase decision.

REFERENCES:

I. Zhao W. , Wang Y. and Guo Z. (2011). “The Air Traffic Congestion Analysis for Landing”, International conference on Information Technology, Computer Engineering and Management Sciences (ICM), pp. 100-103.

II. Yifei Z. and Kai C. (2010). “Air traffic congestion assessment method based on evidence theory”, Control and Decision Conference (CCDC), pp. 426-429.

III. Lee H. and Balakrishnan H. (2008). “A study of tradeoffs in scheduling terminal-area operations”, Proceedings of the IEEE, Vol. 96, No. 12, pp. 2081-2095.

IV. Abara, J. (1989). "Applying integer linear programming to the fleet assignment problem". Interfaces 19 211–232.

V. Barnhart, C. et al. (1998). Flight strings models for aircraft fleeting and routing. Transportation Science, 32(3).

VI. Bazargan, M.,(2010).“Airline Operations and Scheduling”, 2ND Edition, Embry-Riddle Aeronautical University, USA, Burlington, ASHGATE Publication.

VII. Cordeau, J., Stojkovic, G., Soumis, F., Desrosiers, J. (2001). Benders decomposition for simultaneous aircraft routing and crew scheduling. Transportation Science 35 (4), 375–388.

VIII. De Falco , A. Della Cioppa , E. Tarantino. (2002). Mutation-based genetic algorithm: performance evaluation , Applied Soft Computing 1 (2002) 285–299 .